Description

Method and arrangement for optimizing of an amplitude-modulated optical signal

The invention relates to methods according to the preamble of patent claim 1, and to an arrangement according to the preamble of claim 6.

Digital signals are frequently transmitted in optical networks with the aid of amplitude modulation (ASK). A carrier wave is transmitted in the case of one logic state, and no signal is transmitted during the other logic state. As early as the modulation (on-off), what is termed a chirp is produced in which the wavelength of the output signal, and also the amplitude thereof, are changed. The transient component of the chirp causes large variations in the region of the edges, a sharp increase or decrease, [sic] in the wavelength, the switch-on edge being of particular importance, since the changes occur in the case of a full signal level. The other, adiabatic component of the chirp can be kept small by a suitable design of the modulator.

During transmission of the pulse in a waveguide (glass fiber), self-phase modulation of the carrier occurs, this being a further form of the chirp, in which the wavelength changes likewise particularly in the leading edge region and trailing edge region of the pulse. Amplitude distortions can occur, in addition.

The two wavelength distortions, the transient component of the chirp induced by switching on, and the self-phase modulation result in pulse distortion of the baseband signal which, particularly in the case of transmission systems with high bit rates, contribute to limiting the data rate and the transmission range.

An attempt is usually made to minimize the chirp-induced disturbing influences by setting operating points of Mach-Zehnder modulators or integrated electro-absorption modulators in the test bay. However, resettings must be undertaken when changes occur to the operating parameters.

GB 2 308 675 A discloses an arrangement and a method for driving an optical modulator. The printed publication describes the setting of a chirp parameter. Monitoring the modulated signal is performed at the receiving end, in order to set the chirp parameters via a back channel for pulse compression.

GB 2 316 821 A describes an optical time-division multiplex system which compensates the chromatic dispersion of the transmission path by means of controlled chirping of the transmitted signal. Monitoring of the modulated signal is not provided.

From [sic] the earlier application EP 0 971 493 A1 likewise describes a method for compensating dispersion and nonlinearities in optical communication systems. In this system, however, it is, for example, the error rate which is measured and the transmission level which

is controlled as parameters. Both measures do not appear to be expedient in modern optical systems.

It is therefore the object of the invention to specify a method and an arrangements [sic] for permanent optimization of the pulse shape/spectral distribution of an amplitude-modulated optical signal, particularly taking account of the modulation-induced chirp and the self-phase modulation in optical transmission systems.

Achievements of this object are specified in the independent claims. Advantageous developments of the invention are specified in the subclaims.

The measures according to the invention consist in using quality criteria for optimal modulation of the optical signal to set the operating point of the modulator and to maintain the optimum setting by means of a control loop.

An advantageous and simple solution is to derive a measuring signal from the modulated optical digital signal and feed it to a frequency discriminator. The output signal of the latter is - [sic] led via a control device - [sic] which determines the operating point of the modulator.

If the measuring signal is tapped at the receiving end, the properties of the transmission path can be taken into account by means of an adjustable reference signal. The output signal of the modulator is set so as to produce an optimal received signal.

If a back channel, as a rule a service channel, is available, a measuring signal can be tapped from the baseband signal and evaluated. The spectral distribution signal output by a phase discriminator, or a control signal generated therefrom will be transmitted to the source of the signal, the modulator.

The invention is explained in more detail with the aid of an exemplary embodiment.

In the drawing:

Figure 1 shows a first exemplary embodiment with spectral appraisal.

Figure 1 shows a first exemplary embodiment of a control loop for optimizing the modulation-induced chirp. The block diagram shows only modules essential to the invention. A laser provided as a narrow-band light source 1 supplies an optical signal OS of high frequency, which is fed to a modulator 2. The latter is submitted to amplitude modulation by means of a digital signal DS (on-off keying). The modulated optical signal OSM, output by the modulator, is fed into an optical conductor of a transmission path 3 and transmitted. A measuring signal OMT of low power is tapped from the modulated signal via a splitter (coupler) 4 and fed to a frequency discriminator 5. The latter can include, for example, an optical filter whose edge, which is as rectilinear as possible, is used for frequency

demodulation. The demodulated optical signal is converted into an electric spectral distribution signal SV and fed to a control device 6. The latter is fed as reference input an adjustable reference signal RS which is generated via a reference setting device 7, a voltage divider in the example. The control device supplies as manipulated variable a control signal SR which sets the operating point of the modulator and thereby optimizes the transient chirp of the modulated optical signal even in the case of changes in the component properties.

An optimum setting is given when the receive signal is optimal. A measurement at the receiving end is actually required for this purpose. However, a compact replacement transmission path used for the setting likewise permits an exact setting. The spectral distribution signal serves as criterion during setting. A specific envelope of the modulated signal corresponds to this criterion, and can likewise serve as criterion.

If the properties of the transmission path are known, they are already taken into account during setting, and the spectral distribution (or a pulse shape) is set so as to produce optimal receiving conditions.

Since the spectral distribution signal SV can be weakly dependent on the on the [sic] bit sequence of the digital signal, it can be expedient to have a time window ZF during which specific bit sequences are transmitted and the control signal is determined.

It remains to add that the control signal RS and the digital signal can be combined by an adder, and the aggregate signal is then fed to the modulation input of the modulator.

As in the arrangement illustrated in figure 1, it is also possible, of course, to appraise the spectral distribution of a modulated optical signal at the receiving end, and a corresponding spectral distribution signal or else the control signal derived therefrom is transmitted [sic] to the transmitting part.

List of reference symbols

DS	Digital signal
DD	Demodulated digital signal
1	Laser
2	Modulator
3	Optical conductor
4	Splitter
5	Discriminator
6	Control device
7	Reference setting device
RS	Reference signal
OS	Optical signal
OSM	Amplitude-modulated optical signal
OMT	Measuring signal
SV	Spectral distribution signal
SF	Control signal
ZF	Time window
8	Summing device
9	Receiving device
10	Optoelectric transducer
11	Amplifier
12	Decision circuit
13	Data output
14	Measuring instrument appraising device
15	Evaluation device
16	Controller
17	Modulation input
18	Transmitting device
19	Receiving device
SE	Setting signal